The Target Generation Facility (TGF)

Data Reduction and Analysis Toolkit

DRAT

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The TGF Data Reduction & Analysis Toolkit

User's Manual

Created by the Target Generation Facility, located at the website

WWW.TGF.TC.FAA.GOV

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OVERVIEW

The TGF Data Reduction and Analysis Toolkit (DRAT) was developed to generate reports on air traffic control simulations for data analysis. Researchers can use this tool to analyze and interpret various sets of dependent variables that relate to both air traffic system performance and individual controller performance. Analysts will be able to evaluate the output of the tool with statistical packages without manual elimination of extraneous raw data.

Analysts without any prerequisite programming skills can quickly learn how to use the tool. The menu-driven graphical user interface (GUI) allows easy customization of data output and tailoring of data reports to meet the research analysis requirements of the studies being conducted. The tool's menu-driven interface allows the selection of TGF simulation recordings. The analyst can select data from sets of variables for output, process summary statistics based on user-specifiable time blocks, and print the output generated to the desired format. The output can be printed to either a text format for reading or to a comma-delimited format compatible with spreadsheet import files such as those used by MS-Excel, Lotus 1-2-3, or Quattro Pro. Frequently used data output formats can be saved and are accessible through menus.

Among the types of reports the data reduction and analysis tool is capable of producing are system complexity measurement reports, system activity/load measurement reports, and conflict reports on aircraft violation of separation requirements, aircraft characteristic reports, and navigational information reports. Frequencies and duration of events can be determined over the length of the simulation or over specifiable intervals of time. The reports can be adapted to meet the analysts' needs and, as such, are highly customizable.

The following documentation includes a user's manual that includes illustrations of the GUI panels, descriptions of the data filters, and a glossary of FAA simulation research terms.

1 Introduction and Basic Concept

The DRAT toolkit is a modular, highly adaptable application for extracting data from TGF simulations for the benefit of the customers' analysts. Since the TGF simulator records exhaustive detail on the state of the simulation, customers that look at the simulator data want to quickly reduce the amount of information to the set of details that is pertinent to their particular study. The DRAT toolkit provides tools to select on a wide variety of data elements to construct a subset of the simulator data that can be analyzed easily. DRAT can also produce summary information about a simulation. This is all packaged with an easily operated Graphical User Interface (GUI) interface.

The following definitions are commonly used terms for the DRAT application:

Configuration - a sequence of DRAT tools that operates on TGF simulator data to generate (at least) one set of output. (Some types of configurations can produce multiple output files containing different sets of output.) Each DRAT tool in the sequence operates on the simulator data resulting from the previous tool in the sequence. A minimum of two tools is needed to produce output (a reader and either a writer or plotter).

Data Object - is a set of related information such as aircraft information, fix information, or pilot (pseudo-pilot) command information. In effect, a data object can be thought of as a record with multiple fields.

Recording File - is a file containing "data objects" detailing the initialization parameters of a TGF simulation, second-by-second information on the state of the simulation, and messages describing events that occurred during the simulation.

Reader - allows the selection of an input file to translate data into "data objects" that the other DRAT tools can operate on. Currently the only reader is the Recordable Reader, which imports files in TGF simulator recording format.

Filter - allows the selection of a subset of "data objects" by removing objects not containing a specified characteristic that the filter was designed to select for.

Factory - combines information from existing "data objects" to create new sets of information encapsulated in new data objects.

Writer - allows the selection of an output file in a specific format. Each writer generates a report to an output file, which can be read by an editor or sent to a writer.

DRAT operates by taking a configuration of the DRAT tools, and subjecting the TGF simulator data to each tool's process in sequence. The reader tools construct data objects by importing data from a file; subsequently, the other tools select from the data received, construct new data objects, or generate output for the user. Each tool operates on all the data objects it receives according to its function and then sends the resulting data objects to the next tool. The DRAT GUI displays the configuration in a top-to-bottom sequence that should, at minimum, start with a reader and end with a writer or plotter. Frequently requested configurations have been pre-defined, and can be loaded from the file menu. Configurations may also be constructed by the user and, if desired, saved for future reuse.

2 Parts of the DRAT GUI

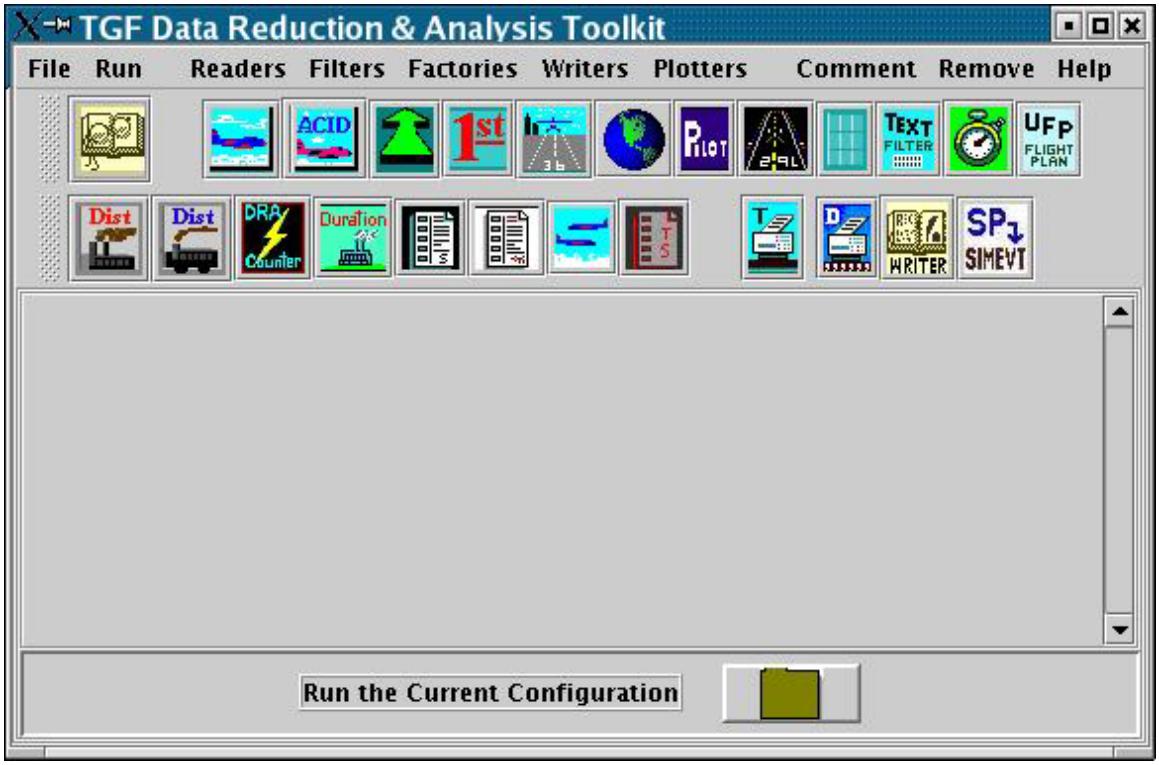


Figure 1

Welcome to the TGF Data Reduction and Analysis Toolkit GUI. The DRAT GUI will provide assistance in the extraction and formatting of simulation data, for use in the analysis of simulation results.

The DRAT GUI has several main sections: the menu bar, from which all operations can be performed, the toolbar, which provides fast access to the frequently used DRAT tools (for placement on the tool configuration workspace below), and the tool configuration workspace, where the selected tools are displayed, allowing the individual tools to be configured.

2.1 The Menu Bar

Figure 2

The menu bar is the access point for the actions and tools to be used when operating the DRAT GUI. Selecting a tool on one of the menus will cause the tool to be placed after any previously selected tools in the list displayed on the tool configuration workspace. (Individual menus are described in Section 3: The Menus.)

2.2 The Toolbar

Figure 3

The toolbar provides quick access to a subset of the DRAT tools. The icons represent the DRAT tools that are the most often used. Selecting any of these icons causes the same result as selecting the corresponding tool from the dropdown menu bar.

2.3 The Tool Configuration Workspace

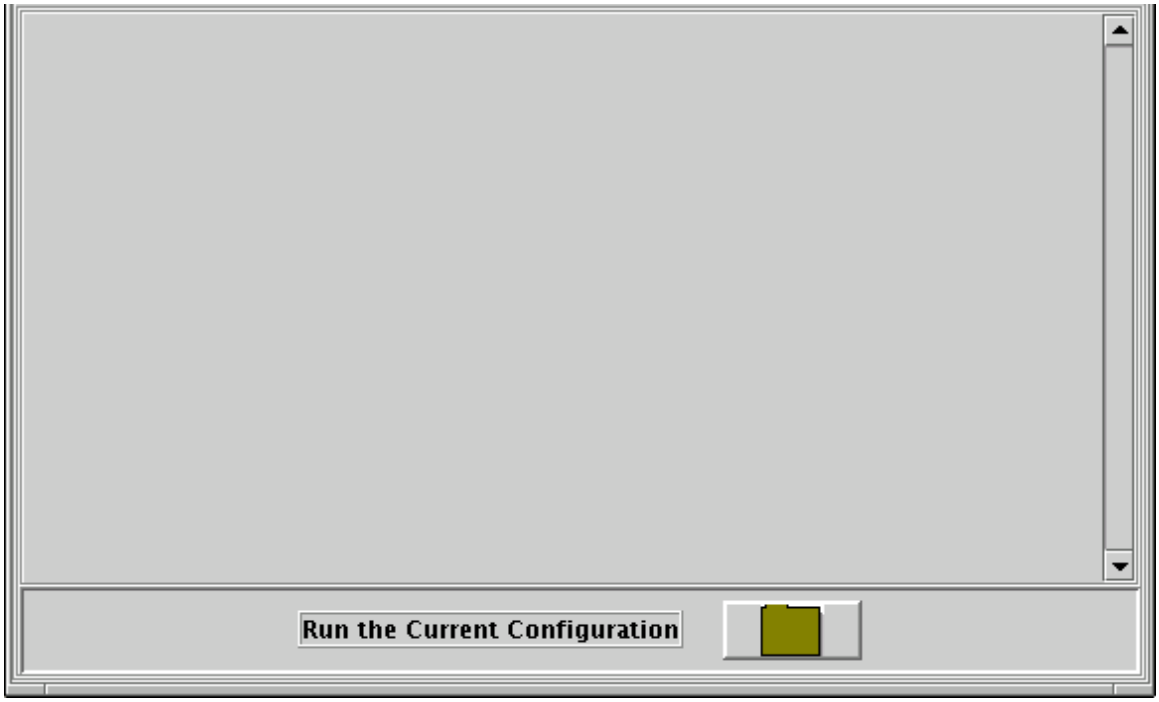


Figure 4

The tool configuration workspace is where the selected sequence of DRAT tools is displayed and constructed to create the desired data reduction output. The layout of the tool configuration panels, from top to bottom, is the order in which each tool acts upon the Data Objects received from the previous tool.
The panels for the DRAT tools can be added by choosing a menu selection or by selecting a button on the quick-access toolbar. They can be removed by selecting a Remove menu option or by right-clicking on the panel title and selecting "Delete".

3 The Menus

3.1 File

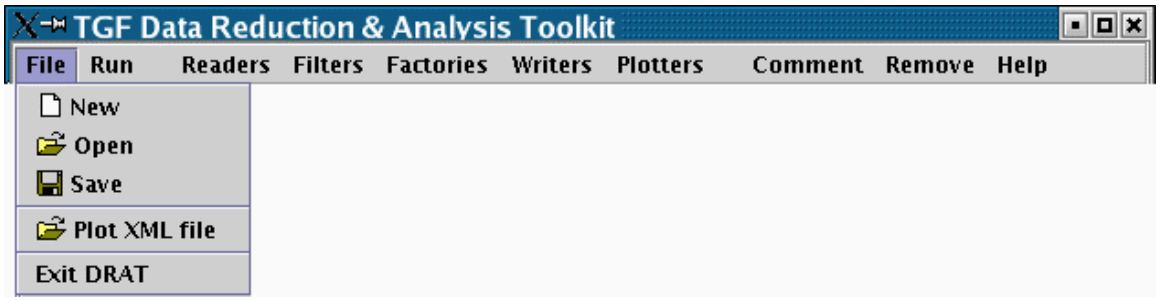


Figure 5

When File is pressed, the File Menu pops down. The user is presented with choices on the data reduction and analysis setup. The user can clear the tool configuration workspace, open a previously saved configuration and display it on the workspace, save the current configuration, or exit the DRAT GUI. The user may also open and display the plotted coordinates of an XML file in the Berkeley Ptolemy II plot format (see http://ptolemy.eecs.berkeley.edu/java/ptplot), which can be generated by a DRAT tool.

3.2 Run

Figure 6

The Run Menu allows the user to run the current configuration. The user can either run the current configuration from this location or click the shortcut folder icon (shown below) that appears at the bottom of the tool configuration workspace.

Figure 7

3.3 Readers

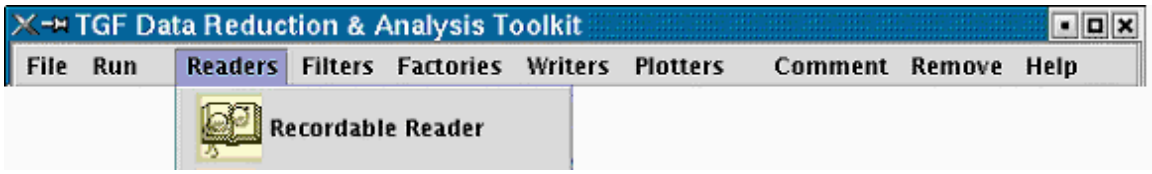


Figure 8

Readers provide the ability to select an input file in an encoded format. The Recordable Reader chooses a TGF recording file as a data source. When the configuration is run, the reader will read the file's information and translate it into Data Objects. The data objects generated are sent on to the next tool in the sequence.

Selecting a tool from the Reader menu opens a reader panel inside the GUI workspace.

Recordable Reader – the standard reader: reads a TGF recording file containing simulation data (for details, see 4.1.1)

3.4 Filters

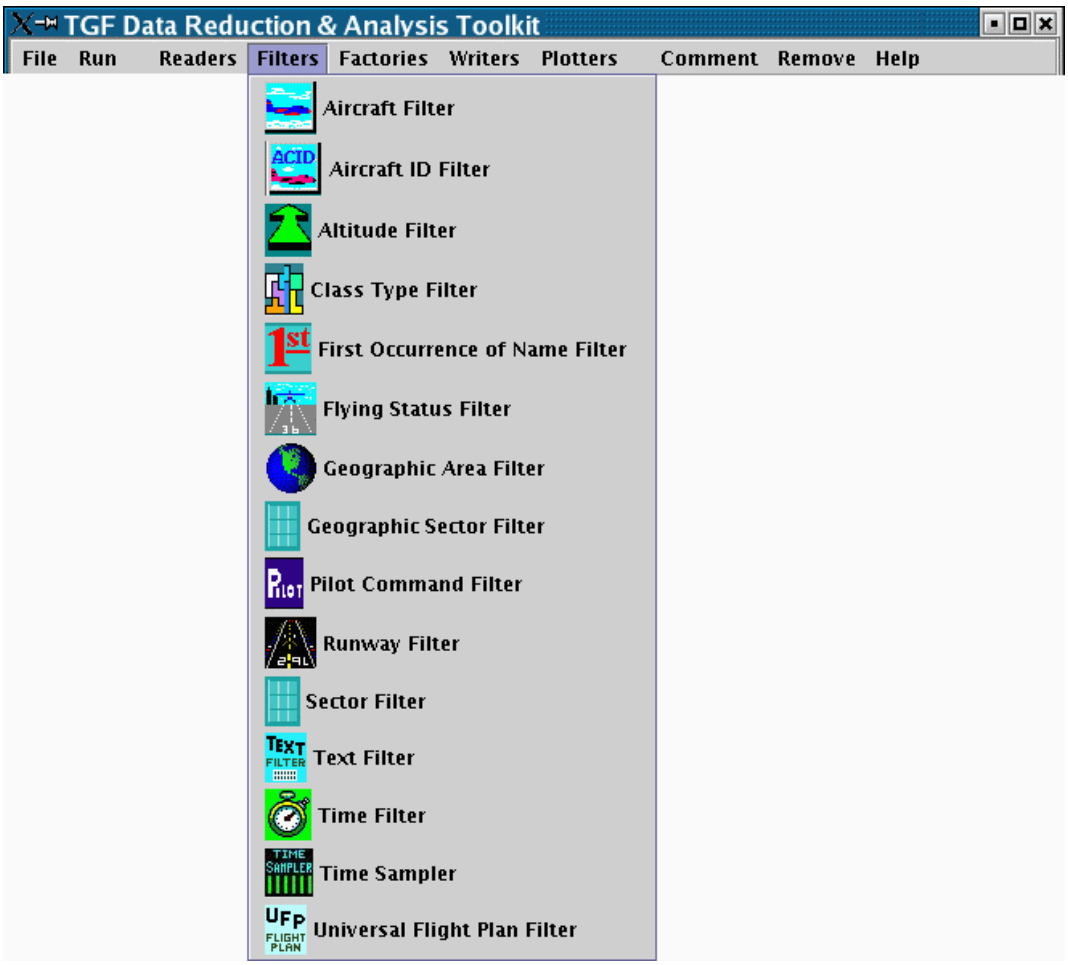


Figure 9

The Filters Menu gives the user all of the filter names and their corresponding icons.
These filter icons indicate panels that allow selection of a subset of data.


Aircraft Filter - filters second-by-second aircraft state data, by ACID or beacon code (for detailed description: see 4.2.1)

Aircraft ID Filter - filters on any data object having an associated aircraft, by aircraft ID or beacon code (for detailed description: see 4.2.2)


Altitude Filter - filters Data Objects with an altitude by the altitude range specified (for detailed description: see 4.2.3)


Class Type Filter - filters for a specified type of Data Object (see 4.2.4)

First Filter - sends only the first instance of data objects with the same name (prevents state updates - (see 4.2.4)


Flying Status Filter - filters second-by-second information for aircraft by their current flying status (see 4.2.6)


Geographic Area Filter - filters data objects with a location by a set of geographic boundary coordinates (see 4.2.7)


Geographic Sector Filter - filters data objects with a location by the geographic coordinates of the named sectors, if that data was recorded (see 4.2.8)

Pilot Command Filter - filters pilot commands by their defined type (see 4.2.9)


Runway Filter - filters by a set of specified runways for data objects with associated runways (see 4.2.10)


Sector Filter - filters by a set of specified sectors for data objects with associated sectors (see 4.2.11)

Text Filter - filters on text output that would be generated by the DRAT Text Writer (see 4.2.12)


Time Filter - filters time stamped data objects by a time interval (see 4.2.13)

Time Sampler - samples time-stamped data objects by only sending objects that occur at a multiple of a time interval

Universal Flight Plan Filter - filters on aircraft-related info of aircraft having a UFP field match (see 4.2.15)

3.5 Factories

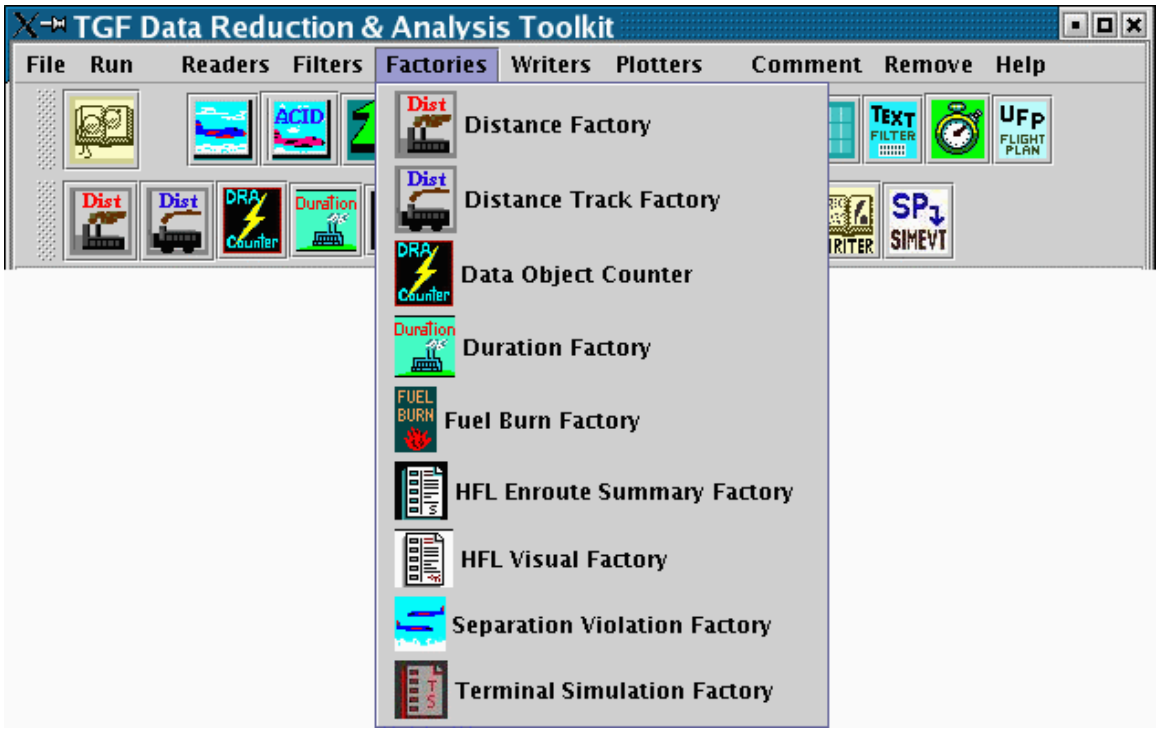


Figure 10

The Factories Menu opens to reveal a selection of factories, or object generators. Generally, a factory is used to provide calculated data or summary information, so the analyst does not need to perform the calculations manually.

Distance Factory - generates specific distance information for aircraft (see 4.3.1)

Distance Track Factory - generates ground track distance traveled for aircraft (see 4.3.2)

Data Object Counter Factory - generates totals and interval subtotals of data objects received (see 4.3.3)

Duration Factory - generates duration reports on time-stamped data received (see 4.3.4)

Fuel Burn Factory - creates a data file to import into the fuel burn calculation tool (see 4.3.5)

HFL Enroute Summary Factory - generates summary information relating to an enroute simulation (see 4.3.6)

HFL Visual Factory - generates graphical summary data on aircraft status (see 4.3.7)

Separation Violation Factory - generates detailed information about separation violations (see 4.3.8)

Terminal Simulation Factory - generates summary information relating to a terminal simulation (see 4.3.9)

3.6 Writers

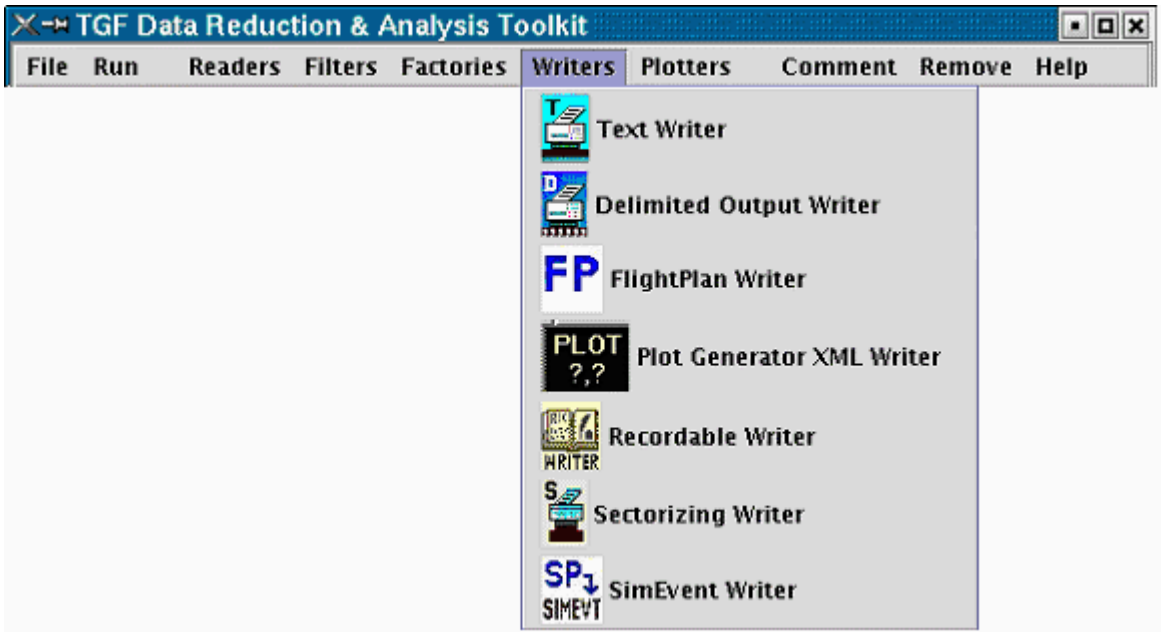


Figure 11

Writers allow the selection of an output file in a specific format. Each writer generates a report to an output file that can be read by an editor, or sent to a writer.
When the Writers Menu is selected, the file writer tools are listed for selection. The most used writers are the Text Writer, which produces easily readable text output for the objects received and the Delimited Writer, which writes the data to comma-separated format.

Text Writer - saves output to easily readable text format (see 4.4.1)

Delimited Writer - saves output of pre-configured data objects to comma-delimited format (see 4.4.2)

Flight Plan Writer - recreates the flight plan of the current TGF recording (see 4.4.3)

Plot Generator XML Writer - writes an XML file with plotted comparison of one data object field to another (similar to XY Plotter - (see 4.4.4)

Recordable Writer - stores data objects received back to TGF recording format (see 0)

Sectorizing Writer - separates info by sector, writing to files named with the sector name (see 4.4.6)

SimEvent Writer - converts SP commands to SimEvents (automated command entries) and writes them to XML text format (.evt) (see 4.4.7)

3.7 Plotters

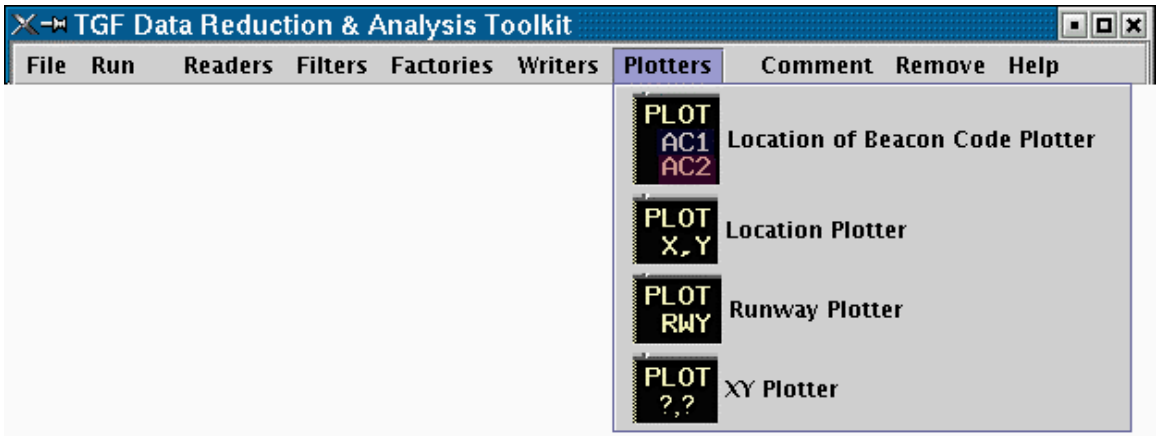


Figure 12

Aircraft Location Plotter - plots location points of aircraft to a visual plotter: changes color for different beacon codes (see 4.5.1)

Location Plotter - plots location points of objects received to a visual plotter (see 4.5.2)

Runway Plotter - plots boundaries of runways received to a visual plotter (see 4.5.3)

XY Plotter - plots comparison of one data object field to another (similar to Plot Generator XML Writer - (see 4.5.4)

3.8 Comment

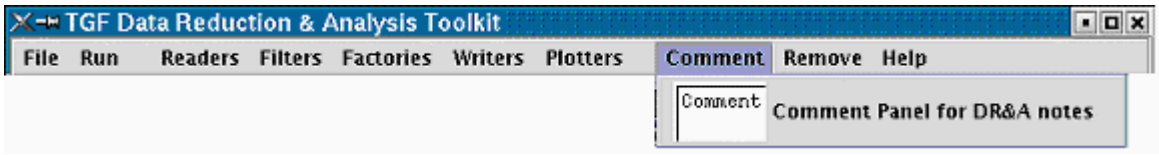


Figure 13

Provides a text area in which to store notes on the DRAT configuration.

Figure 14

3.9 Remove

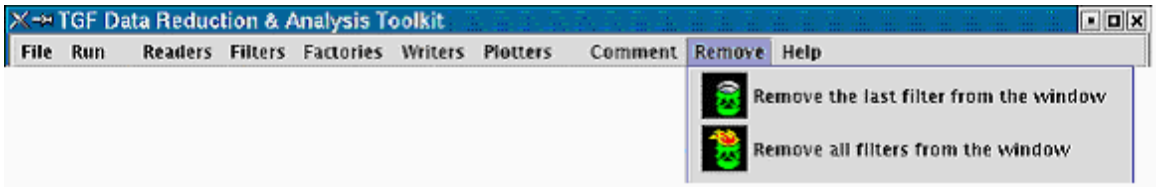


Figure 15

The Remove menu has two options:

 allows the user to remove the last filter from the scrolling panel,

 removes all the filters that are open in the scrolling panel.

3.10 Help

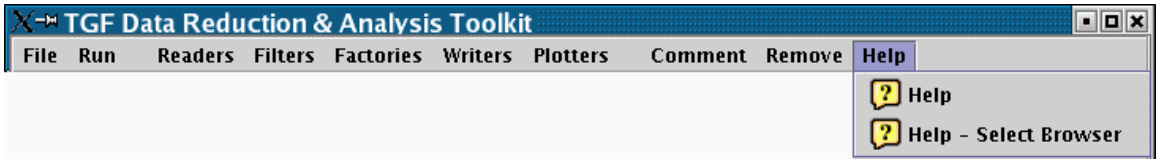


Figure 16

When the user selects the Help Menu, the DRAT user's manual (in HTML format) opens in a new window. The first help option displays the user's manual in a barebones HTML viewer. The "Select Browser" option allows the DRAT user's manual to be displayed by a user-selected browser or HTML editor--a file chooser allows the user to specify the executable to use, and the URL for the user's manual is used as a parameter to the executable file.

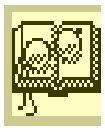
4 The Tools

These are the DRAT tools that can be arranged together to create data reduction and analysis output; they generate output using a modular, sequence-dependent configuration structure. The first tool in a configuration must be a reader so that the following tools have data objects to operate on. The reader tools construct data objects by importing data from a file; the other tools select from the data received, construct new data objects, or generate output for the user. Each tool operates on the set of data objects it receives according to its function and then sends the resulting data objects to the next tool in the top-to-bottom sequence. (See the Introduction for a more detailed description.)

4.1 The Readers

A reader constructs data objects from information in an input file. The first tool on the DRAT configuration panel should always be a reader, since the readers are the only DRAT tools that do not need to receive data objects from other tools.

4.1.1 Recordable Reader



The only current reader tool is the Recordable Reader. The Recordable Reader provides the ability to select a TGF recording file to generate data objects from. The output generated consists of all the data objects as they were recorded to TGF format. Section 5.0 provides a list of different types of data objects.

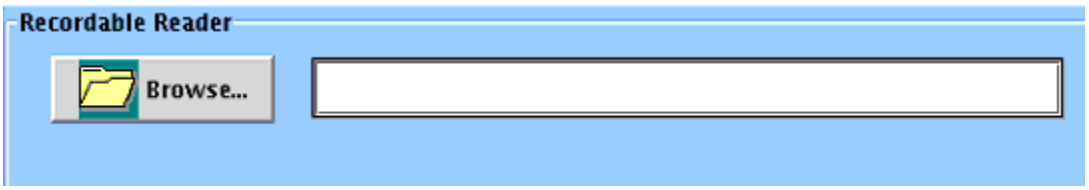


Figure 17

4.2 The Filters

Filters provide the means to select a subset of received data objects, deciding which are to be sent to the next tool based on the information contained within the data objects. The filters operate by eliminating data objects that do not meet certain constraints and sending the rest of the data objects to the next tool. Several filters can be used in sequence to select for several categories of criteria.
Most filters have a "Pass Through" selection option. This field is an option if there is a question of whether to send objects that are not directly selected for by the filter criteria. For example, if a sector filter is told to select for sectors 17, 18, and 38, the filter will always eliminate data objects that contain a sector field that is not one of those 3 sectors. However, data objects that do not contain an associated sector field are not covered by this selection process; therefore, checking the pass through field would cause data objects that do not have sector fields to be sent on.

4.2.1 Aircraft Filter

The Aircraft Filter panel filters aircraft state objects by aircraft ID or beacon code. The aircraft to be sent to the next tool are selected by entering their aircraft IDs or beacon codes into the parameter field. If the aircraft ID parameter field is left blank, all aircraft objects are sent through the filter. Selecting Pass Through will allow non-aircraft objects to pass through the filter.

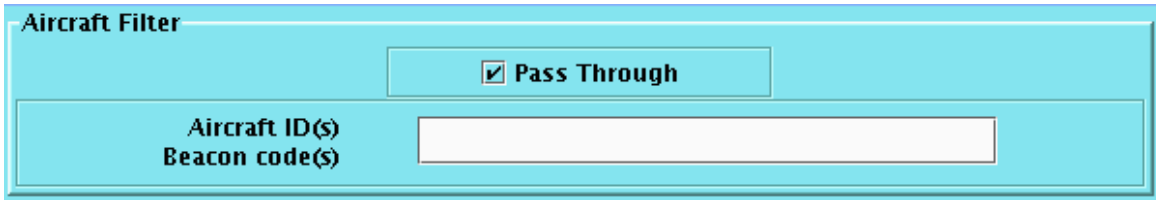


Figure 18

4.2.2 Aircraft ID Filter

The Aircraft ID (ACID) Filter panel filters on any data objects with an associated aircraft, by aircraft ID or beacon code. The aircraft-related data objects to be sent to the next tool are selected by entering aircraft IDs or beacon codes into the parameter field. Only objects that are associated with an aircraft matching these criteria will be passed through the filter. If no aircraft ID is selected, all aircraft associated objects are sent. Selecting Pass Through will allow objects not associated with an aircraft ID to pass through the filter.

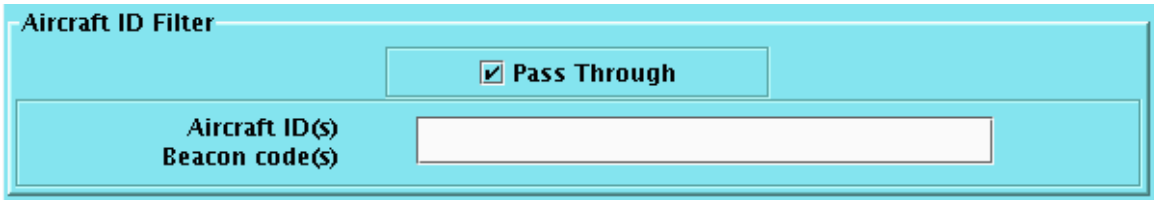


Figure 19

4.2.3 Altitude Filter

The Altitude Filter operates on data objects that have an associated altitude; for example, the Aircraft State object, which represents the second-by-second state of an aircraft, has an altitude as part of its position information. The user can specify the minimum and maximum altitude limits of objects the filter will allow through. Selecting Pass Through allows data objects that do not have an associated altitude to pass through the filter.

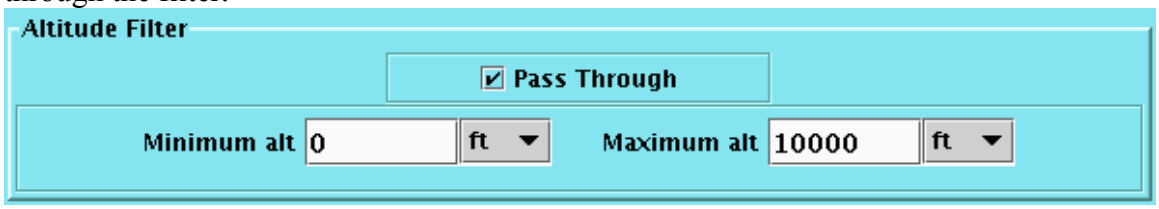


Figure 20

4.2.4 Class Type Filter

The Class Type Filter provides a generic filter that selects a data object by type. Section 5.0 lists the data object types. This filter is used to specify the selection or elimination of a single type of data.

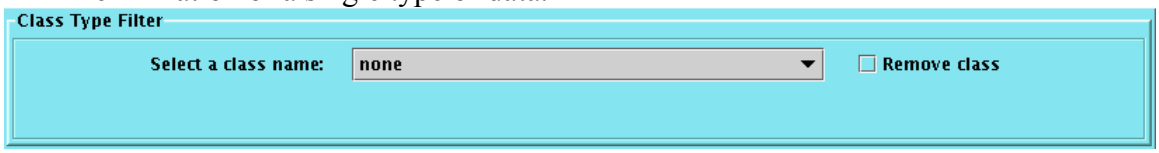


Figure 21

4.2.5 First Occurrence of Name Filter

The First Occurrence of Name Filter looks for objects that have a defined name fields and only sends through the first occurrence of a specific name for an object type. For example, by selecting a configuration sequence of:
Recordable Reader (specifying input file)
Aircraft Filter (blank to indicate all aircraft; Pass Through off)
First Occurrence of Name Filter
Text Writer (specifying output file),
the result would be the aircraft state information for each aircraft's starting second (aircraft do not have state information until they are activated), written to text format output. Objects that do not have a unique name will pass through this filter.

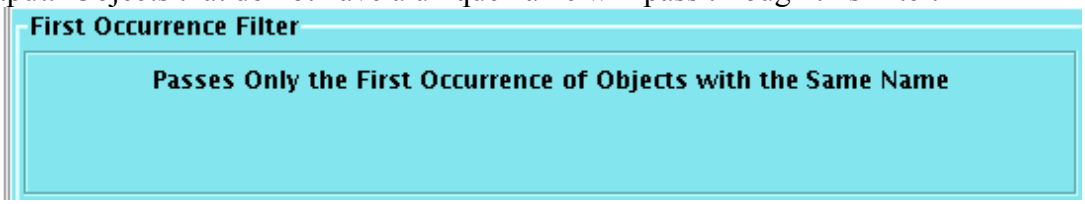


Figure 22

4.2.6 Flying Status Filter

The Flying Status Filter filters objects based on the phase of flying or the rules of flying the aircraft is operating under.

The specific, exclusive flying states are:

```
Gate Hold
Departing
On Route (filed flight plan)
On Vectors (not on filed flight plan, but not in another state)
Hold
ILS Before Final (on ILS, on localizer but not yet on final approach)
Non-ILS Before Final (not on ILS, on localizer but not yet on final
      approach
ILS Final Approach
Non-ILS Final Approach
Past Thresh (aircraft has passed the runway threshold and is landing)
Missed Approach
Landed
Terminated (the aircraft is no longer active in the simulation)
Cockpit Controlled (with a cockpit simulator)
Dead Reckoned (designation for aircraft displayed by TGF that were
      generated by another simulator)
```

Certain groups of flying states are also filterable with one Flying Status Filter:

```
All
Flying (not in Gate Hold, Landed, or Terminated state)
Not Flying (in Gate Hold, Landed, or Terminated state)
Not in Gate Hold
Not Landed
On Localizer (ILS or non-ILS, on localizer - possibly on final)
Not On Localizer
```

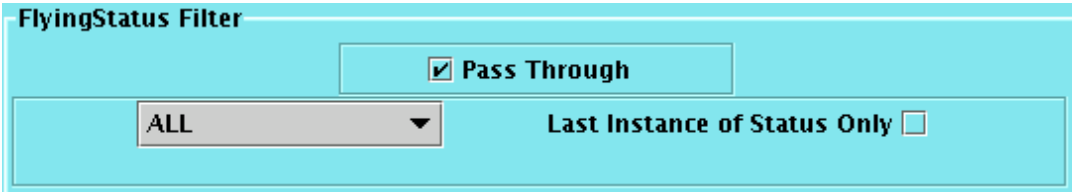
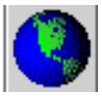


Figure 23

4.2.7 Geographic Area Filter



The Geographic Area Filter filters on data objects with positions inside or outside a geographic location specified by a polygon. By default, all objects within the polygon are passed to the next tool. Selecting "Outside" passes data objects that lie outside the geographic boundaries instead. The geographic boundaries of the polygon can be specified with a series of either latitude and longitude positions or a stereographic projection and x- and y-coordinates. The last coordinate is automatically connected back to the first coordinate to complete the polygon. Selecting Pass Through will allow objects that do not have an associated position to pass through the filter.

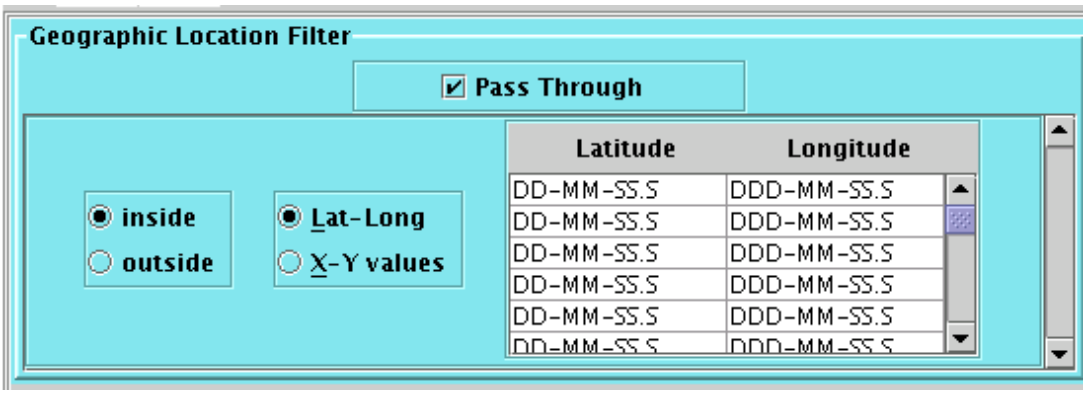
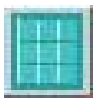


Figure 24

4.2.8 Geographic Sector Filter



The Geographic Sector Filter will filter data objects with locations by the areas encompassed by the specified sectors. For this filter to work, the TGF recording must have had information on the physical coordinates of the sectors available.

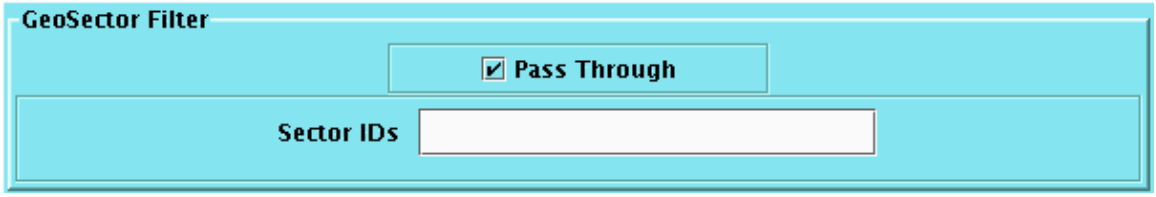


Figure 25

4.2.9 Pilot Command Filter

The Pilot Command Filter selects pilot commands by the type of command. By default, all types of pilot commands are selected. Selecting Pass Through will allow non-SimPilot command objects to pass through the filter.

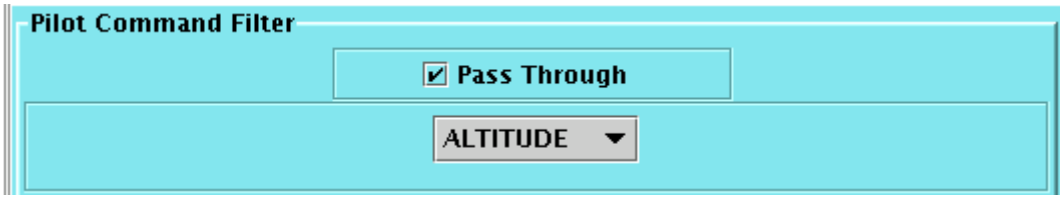


Figure 26

4.2.10 Runway Filter

The Runway Filter passes aircraft objects (e.g. Aircraft State data objects) that have an associated runway. The runways are specified by airport/runway ID, for example; BWI/07L, BWI/27R.

Selecting the following:

Recordable Reader
Aircraft Filter (blank to select all aircraft; Pass Through off)
Runway Filter (BWI/07L; "Arrival runways only")
First Occurrence of Name Filter
Text Writer,

will produce a list of all aircraft landing at Baltimore International Airport on Runway 7 Left with state information for their first active second.

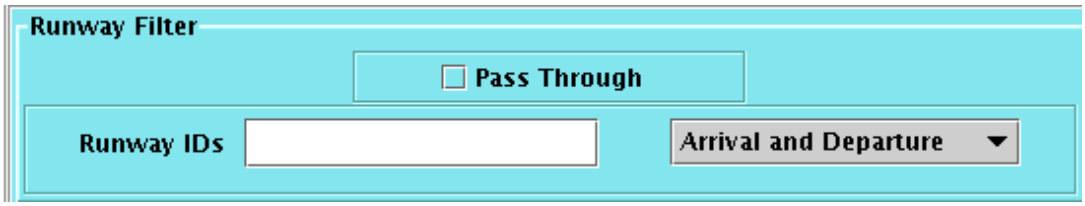
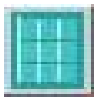


Figure 27

4.2.11 Sector Filter



The Sector Filter allows the filtering of objects that have sectors associated with them. Selecting Pass Through will allow objects not associated with a sector to pass through the filter.

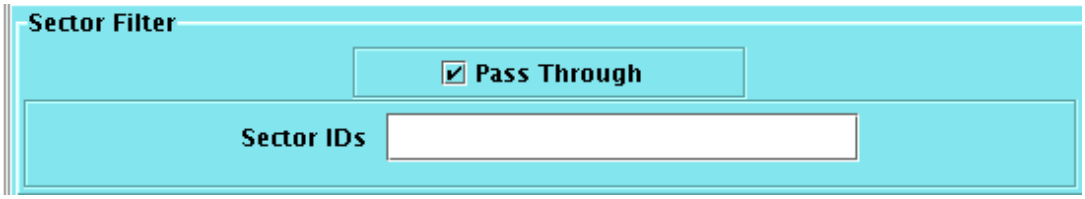


Figure 28

4.2.12 Text Filter

The Text Filter filters objects based on the text output they would generate for Text Writer. The user is allowed to select a search template to look for in the data object text. The template for the search text is expressed in regular expression format; to access an explanation of the regular expression format, click the question mark icon on the panel.

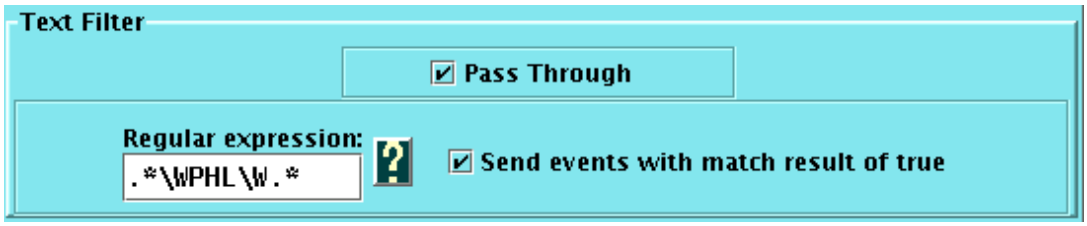


Figure 29

4.2.13 Time Filter

The Time Filter allows for the filtering of events that occur within a set time frame. The events occurring before the start time and after the stop time are discarded.

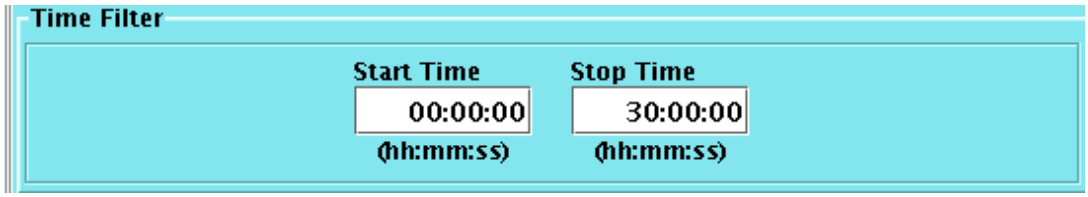


Figure 30

4.2.14 Time Sampler

The Time Sampler samples time-stamped data objects by only sending the objects that occur at a multiple of a time interval. The start time is the first point in time for which time-stamped data objects are sent, and the interval indicates how long it is between subsequent samplings of the time-stamped data objects. For example, if the specified start time is 2 and the specified interval is 10, the filter will send all data objects with timestamps of 0:00:02, 0:00:12, 0:00:22, 0:00:32, etc. Data objects without timestamps are sent if the Pass Through box is checked.

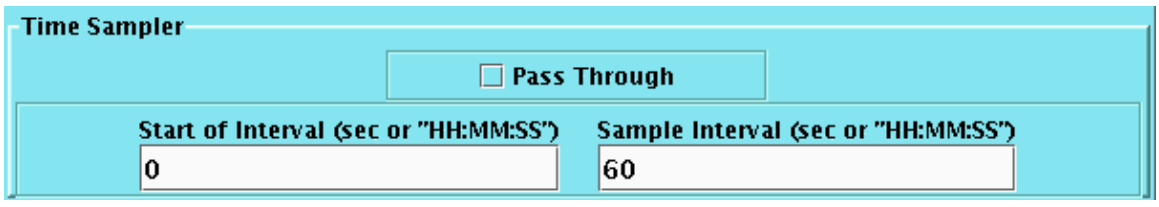


Figure 31

4.2.15 Universal Flight Plan Filter

The Universal Flight Plan Filter filters on objects based on the data in the Universal Flight Plan (UFP). The UFP is a TGF simulator input that describes the initial flight characteristics of an aircraft: the UFP field details are accessible from the TGF documentation web site. The user is allowed to select a search template to filter on for the UFP field. The template for the search text is in regular expression format; to access an explanation of the regular expression format, click the question mark icon on the panel.

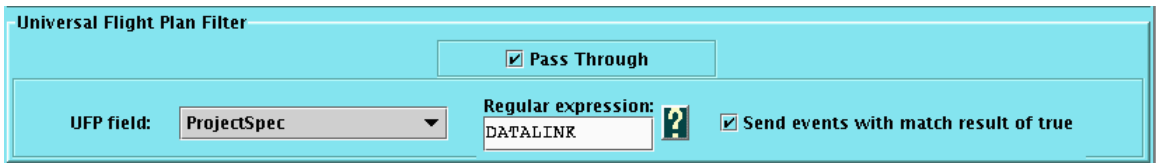


Figure 32

4.3 The Factories

A factory creates a new type of data object from other data objects received. A data object is a set of related information such as aircraft information, fix information, or pilot command information. A factory combines information from existing data objects and then generates new sets of information or, new data objects.
Most factories have a "Pass Through" selection option. This field is an option if there is a question of whether to send objects that are not generated by this factory.

4.3.1 Distance Factory

The Distance Factory generates distance information about an aircraft and another object. The other object must have a location such as a fix, another aircraft, or a runway. Objects are selected by the choice box:

```
VIOLATE_SEP - all pairs of aircraft violating specified separation
VORTEX_SEP - aircraft violating ATC wake vortex separation
CLOSEST_AC - closest aircraft to specified aircraft for each second
SITE_DIST - closest aircraft to a specified site for each second.
```

Selecting Pass Through will allow all objects received to pass through the factory (including the objects the distances are calculated from).

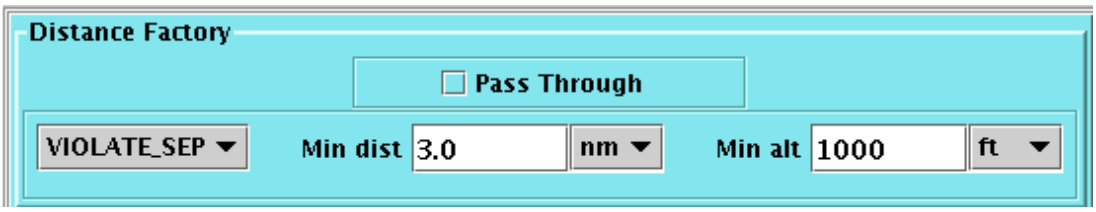


Figure 33

4.3.2 Distance Track Factory

The Distance Track Factory calculates the ground track distance traveled and adds the data to aircraft state objects, allowing the XY Plotter and the Plot Generator XML Writer to compare that value to other values in the aircraft state. The Distance Track Factory also produces summary data objects for each aircraft ID that contain the total time the aircraft was active, totals of both the ground track distance and the actual distance the aircraft travels through the air, and brief information on the aircraft starting state and ending state. If filter values are selected, Distance Track summary objects are not created for aircraft that traveled a distance not within the specified range.

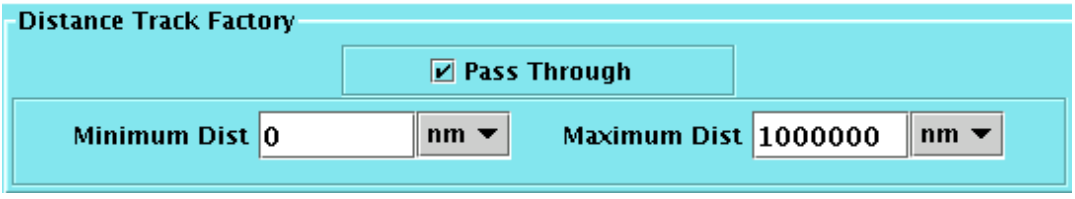


Figure 34

4.3.3 Data Object Count Factory

The Data Object Counter counts objects over a specified interval. Objects can be selected by type, by name, or both at the same time. Selecting Pass Through allows the data objects being counted to pass through the factory (possibly to provide a frame of reference). If the box Count Name Once is checked (turned on) then violations spanning more than one interval are not counted more than once.

.

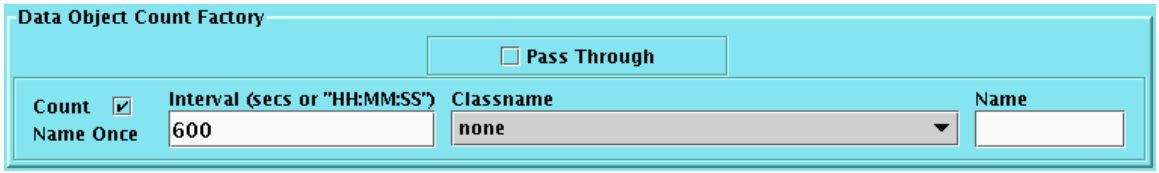


Figure 35

4.3.4 Duration Factory

The Duration Factory generates duration information on types of objects that occur every second. Both minimum and maximum duration can be specified. Selecting Pass Through allows data objects not generated by the duration factory to pass through (possibly to provide a frame of reference).

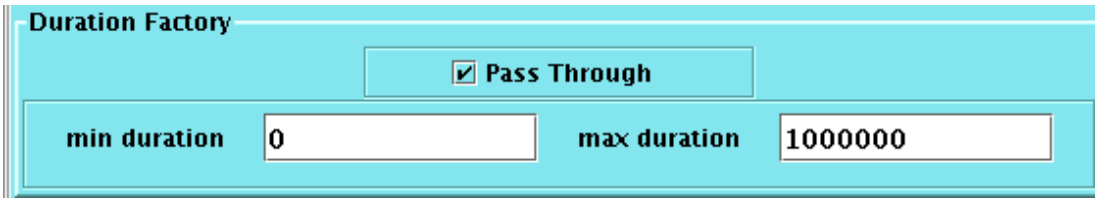


Figure 36

4.3.5 Fuel Burn Factory

The Fuel Burn Factory generates data object that can be written as text that can be imported into a fuel burn calculation tool. This was a special use tool requested by a customer.

Figure 37

4.3.6 HFL Enroute Summary Factory

The HFL Enroute Summary Factory provides statistics on simulation complexity for a sector over intervals of time, including several types of violations: standard separation violation (report abbreviation: secnf), a user defined separation violation (ecnf), between sector standard violations (bscnf), and NTZ area boundary violations (ascnf); number (N) and duration (D) of these outputs are provided, along with hold delays (htdly), takeoff delays (stdly), and other information.
The inputs to the HFL Enroute Summary Factory include the interval of time to count the summary data for and the start time of the first interval (if the interval start is "5:00" and the interval is "10:00", the summary information will count over the intervals: 5-15 min, 15-25 min, 25-35 min, 35-45 min, etc.). The "HFL" titled fields are all simulation identifiers requested by the Human Factors Lab. Horizontal and vertical separation are for the user defined separation outputs. Zero or more NTZ conflict zones can be specified, either in latitude/longitude or in x-/y-coordinates with a stereographic map projection. Pass Through is not provided as an option: the only data objects sent by this factory are the ones it has constructed.
If the user wishes to precede this factory with filters to limit the data that is counted toward the aggregate, care must be taken not to remove too much information, since a wide range of data objects is utilized to construct the summary data objects.

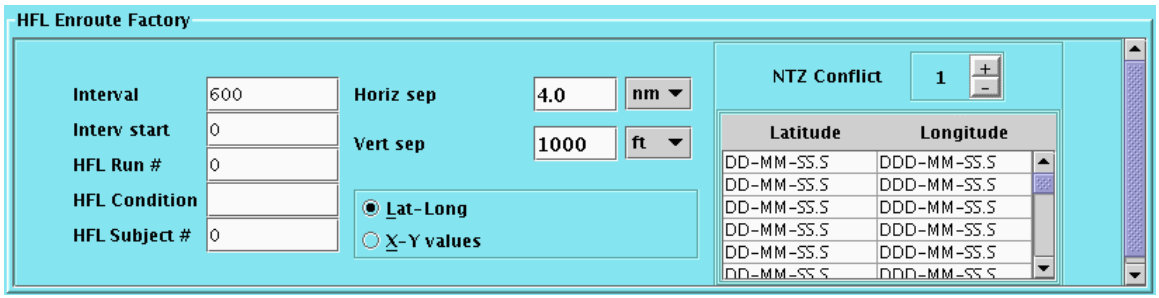


Figure 38

4.3.7 HFL Visual Factory

The HFL Visual Factory provides a visual summary of aircraft distances traveled and sectors used over the time of the simulation. Run number, sample, and condition are identifiers for the type of simulation, and start time and end time tell the time frame to produce the graph for. Pass Through is not provided as an option: the only data objects sent by this factory are the ones it has constructed.
If the user wishes to precede this factory with filters to limit the data that is counted toward the aggregate, care must be taken not to remove too much information, since a wide range of data objects is utilized to construct the visual summary text.
The writer following this factory must be a Text Writer; the data objects constructed by the factory do not have an output process that is accessible by a Delimited Writer.

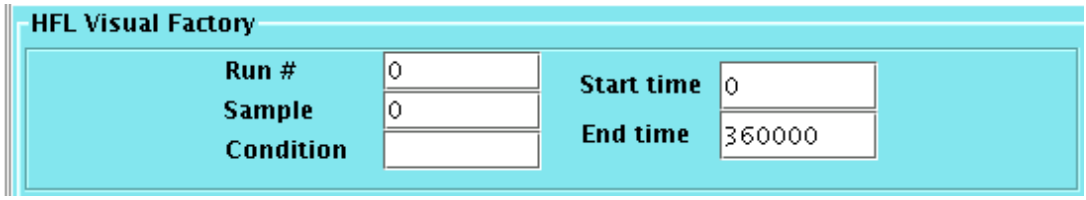


Figure 39

4.3.8 Separation Violation Factory

The Separation Violation Factory provides some detail on separation violations that have occurred. The output info for each violation consists of aircraft IDs of the aircraft involved, time, distance between aircraft, aircraft position and sector information, at the first second of the violation, at the last second, and at the closest point of approach. The separation violation can be either for a defined distance and altitude (including standard violations) or for a wake vortex check (following in trail). The duration field tells the durations of the violations to look for.

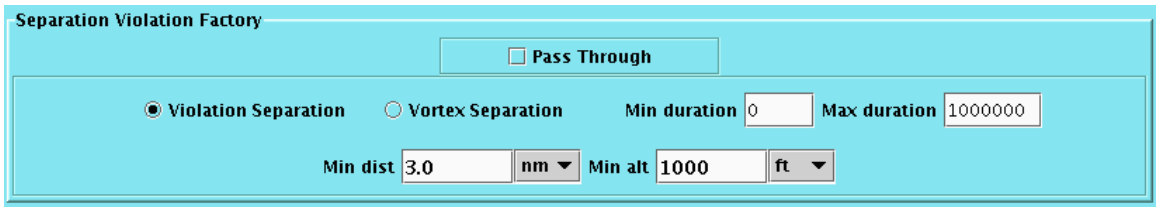


Figure 40

4.3.9 Terminal Simulation Factory

The Terminal Simulation Factory provides statistics on simulation complexity for a sector over intervals of time, including several types of violations: standard separation violation (report abbreviation: secnf), a user defined separation violation (ecnf), between sector standard violations (bscnf), and NTZ area boundary violations (ascnf); number (N) and duration (D) of these outputs are provided, along with

hold delays (htdly), takeoff delays (stdly), and other terminal-related information. The input fields are the same as those of the HFL Enroute Summary Factory. Pass Through is not provided as an option: the only data objects sent by this factory are the ones it has constructed.
If the user wishes to precede this factory with filters to limit the data that is counted toward the aggregate, care must be taken not to remove too much information, since a wide range of data objects is utilized to construct the summary data objects.

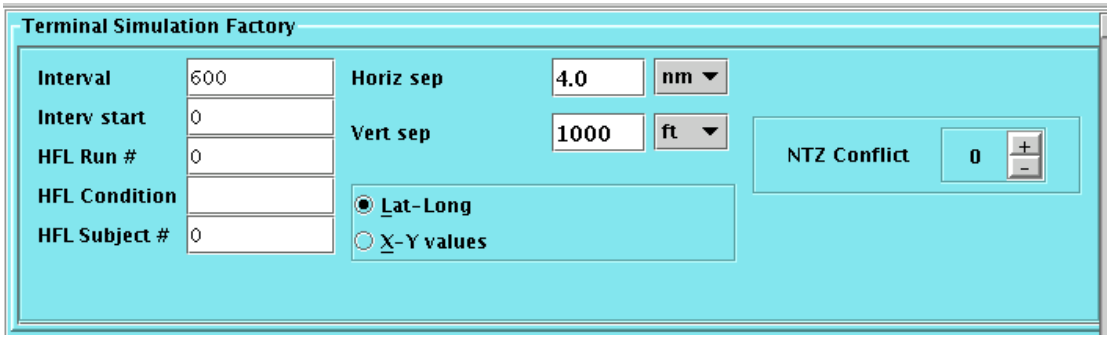


Figure 41

4.4 The Writers

Writers allow the selection of an output file in a specific format. Each writer generates a report to an output file that can be read by an editor, or sent to a writer. The writers send everything they receive to the next tool, if there is one. Either a writer or a plotter should be the last object in the DRAT tool configuration workspace, because the other tools do not generate an output format.
Nearly all data objects have an output process that is accessible by a Text Writer, which produces easily readable text output for the objects received. Most data objects have an output process that is accessible by a Delimited Writer, which writes the data to comma-separated format. All data objects can be written by the Recordable Writer, which stores data objects in the same format that is read in by a Recordable Reader and certain other TGF utilities such as the TGF Simulator Input Utility (see section 4.6).
When the Writers Menu is selected, the file writer tools are listed for selection.

4.4.1 Text Writer

The Text Writer writes easily readable text-format output to a file. The text output is generally in the format "TITLE. Field: <value> Field2: <value2>, …" If xy-coordinates are desired instead of latitude/longitude, the XY box should be checked and a stereographic point of tangency specified.

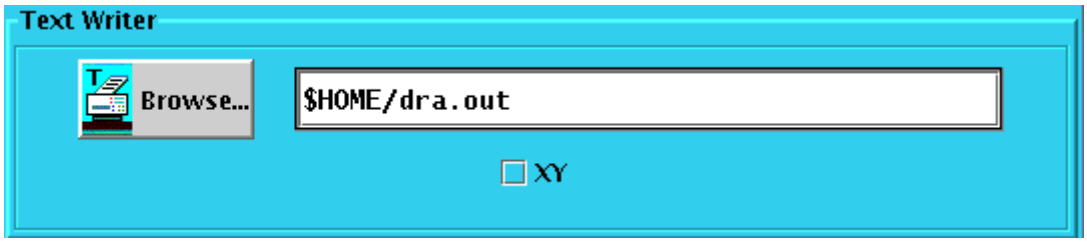


Figure 42

4.4.2 Delimited Writer

The Delimited Writer generates output in character-delimited format. If requested, a header line with field names can be included. If desired, a properties file to specify the units of the output fields can be specified, using the format "<field name>=<unit ID>". If xy-coordinates are desired instead of latitude/longitude, the XY box should be checked and a stereographic point of tangency specified.

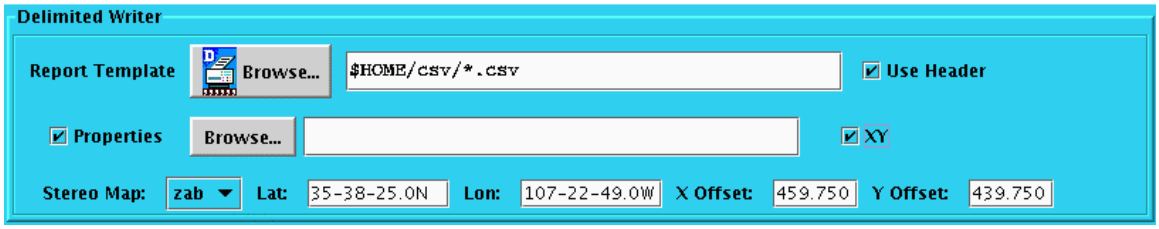


Figure 43

Example of a set of entries that could be in a Delimited Writer properties file:

```
IAS=Knots
TAS=Knots
Lat=deg
Lon=deg
Alt=ft
AltRate=FtPerMin
Hdg=deg
TurnRate=DegPerSec
TotalWeight=lbs
```

4.4.3 Flight Plan Writer

The Flight Plan Writer is a special-use writer that generates the flight plan file that was used to define the initial characteristics of the aircraft in a simulation.

Figure 44

4.4.4 Plot Generator XML Writer

The Plot Generator creates a XML file that can be used as a input into the Berkeley plotting tool, Ptplot, comparing pre-selected field values to each other. This writer is very similar to the XYPlotter in capabilities, except that the XYPlotter actually displays the plot created, while the Plot Generator creates a Ptplot input file that can be used if the plot not to be displayed at the time it is created or if it is to be viewed multiple times.

The Plot Generator needs an input file describing the variables that are to be used for the x and y-axes of the plot; the input file is in XML-format and is described by the XSD description in: tgf\xml\prep\drat\plotter.xsd. The input XML file can be edited, if necessary. The color to use for the plotted points can be specified in case multiple XML plot files are to be imported into one Ptplot display, so that the different inputs can be distinguished. Specify Offset allows the Plot Generator to modify the values stored for display purposes, to add a fixed spacing to the x-coordinate if there is a break in the x-coordinate sequence. This can be useful when comparing certain types of repeated sequences within a plot.

Figure 45

4.4.5 Recordable Writer

The Recordable Writer writes the data objects it receives back to a TGF recording file format. It can be used to select a subset of data from a TGF recording and save it to a file that can be acted on later by other DRAT tools.

Figure 46

4.4.6 Sectorizing Writer

The Sectorizing Writer collates the data objects it receives by sector and writes each set of sector information to separate output files. The output filenames of the sector-separated files is the specified template name with the sector name inserted before the filename extension. The type of writer selected in the panel determines the type of the output files generated: the Text Writer selection will write the data objects as text, the Delimited Writer selection will write the data as comma-separated values, and the Recordable Writer selection will write the data back to the TGF recording format

Figure 47

4.4.7 Sim Event Writer

The Sim Event Writer is a special-use writer that takes the Sim Pilot (pseudo-pilot) commands entered during the simulation and converts them to a SimEvent file. A SimEvent file is an XML file read by the TGF simulator containing pre-prepared Sim Pilot commands to automate actions taken by the aircraft.

Figure 48

4.5 The Plotters

The plotters open a window containing a plot (using the Berkeley Ptolemy II Ptplot tool: http://ptolemy.eecs.berkeley.edu/java/ptplot) of the relationship of two variables to each other. Either a writer or a plotter should be the last object in the DRAT tool configuration workspace, because the other tools do not generate an output format.

4.5.1 Aircraft Location Plotter

The Aircraft Location Plotter plots the location in x- and y-coordinates of all aircraft received giving a top view of their ground tracks. If there is more than one aircraft, the color will change for every different beacon code received.

Figure 49

4.5.2 Location Plotter

The Location plotter plots the location in x- and y- coordinates of all the data objects it receives.

Figure 50

4.5.3 Runway Plotter

The Runway Plotter reads in the location of the runways of the airspace, and draws a rectangle describing the runway layout for each Runway data object received.

Figure 51

4.5.4 XY Plotter

The XY Plotter creates a plot window (using the Berkeley Ptplot tool) that compares pre-selected field values to each other. This plotter is very similar to the Plot Gemerator XML Writer in capabilities, except that the XYPlotter actually displays the plot created, while the Plot Generator creates a Ptplot input file that can be used if the plot not to be displayed at the time it is created or if it is to be viewed multiple times.

The XYPlotter needs an input file describing the variables that are to be used for the x- and y-axes of the plot; the input file is in XML-format and is described by the XSD description in: tgf\xml\prep\drat\plotter.xsd. The input XML file can be edited, if necessary.

Figure 52

4.6 The TGF Simulator Input Utility

The TGF Simulator is capable of displaying radar tracks of aircraft that are derived from a file in the TGF recording format. The TGF recording file does not have to be directly from the TGF simulator, it can be derived from the aircraft data objects selected by a DRAT configuration that includes the Recordable Writer tool. The TGF simulator input utility is accessed through the TGF simulator, which allows a recording file to be selected as input. Since the aircraft are not "flying" according to TGF simulator flight dynamics, these aircraft will have a flying status of "Dead Reckoned", the designation for aircraft displayed by TGF that were generated by a non-cockpit simulator.

5 The DR&A Objects

A data object is a set of data that describes one feature of a simulation. The data objects recorded by TGF encapsulate details about the simulation that are designed to be easily manipulated by the DRAT toolkit, whether by selecting the data objects of interest to the analysts or by extracting data for a summary. Data objects recorded by the simulator are described in this section, plus some data objects constructed by the DRAT tools that describe aspects of the simulation not directly recorded. The data objects indicated by an asterisk are those constructed by a DRAT factory tool.

Airport – Contains airport information.

Aircraft State – A data object containing state information about an aircraft at a specific second. Here is an example of the Text Writer output format for Aircraft State:

```
AIRCRAFT: UAL466  Time: 00:03:13  AC type: A320  Start time: 00:00:05
  Bcn: 2174  Sector: NORTH_ARR  Freq: 128.400  SP: NO_SPW  FS: ILS_BEF_FINL
  Lat: 39-45-04.519N  Long: 075-48-28.184W  Alt: 7788.7 ft  Hdg: 74.69501 deg
  TAS: 279.482  IAS: 249.998 knots  Alt rate: -0.565 ft/m  TurnR: 0.086 deg/s
  Filed: WINGO.NUGGY[CMD=CLA]..PHL
```

Time – current simulation time (0:00:01 is the start of the simulation) in HH:MM:SS
Bcn – beacon code
Start time – simulation time at which the aircraft became active in the simulation
FS - flying status: current phase of navigation of the aircraft. The possible flying statuses are: Gate hold, Departing, On route (following the filed flight plan), On vectors (not on filed flight plan, but not in another specified state), Hold (circling around a fix), ILS before final (on ILS, on localizer but not yet on final approach), NonILS before final (not on ILS, on localizer but not yet on final approach), ILS final approach, Non-ILS final approach, Past threshold (aircraft has passed the runway threshold and is landing), Missed approach, Landed (aircraft has touched down), Terminated (the aircraft is no longer active in the simulation), Cockpit controlled (with a cockpit simulator), Dead reckoned (designation for aircraft displayed by TGF that were generated by another simulator).
Alt rate – rate of change in altitude: positive is climbing, negative is descending
Turn rate – rate of change in heading: positive is turning right, negative is turning left
Filed – the filed flight plan of the aircraft

Additional aircraft dynamics information that is available on request is: desired altitude, desired heading, desired IAS, and desired roll rate.

Distance Second* – A data object constructed by the Distance Factory containing distance information derived from the positions of an aircraft and another object.
A sample of the Distance Second text output produced by Text Writer consists of:

```
Time: 00:22:19  Distance: 2.79006 nm  Horizontal dist: 2.7693 nm  Risk API: 0.0%
  Ac1: AWE179  Lat: 39-58-26.368N  Long: 084-48-30.606W  Alt: 30980.2 ft  Sector: 98
  Ac2: N885Q  Lat: 39-57-35.232N  Long: 084-45-05.074W  Alt: 29035.9 ft  Sector: 88
```

Time – time the distance measurement was made
Distance – slant distance from the aircraft to the object
Horizontal distance - distance between the aircraft not including altitude differences
Risk API - aircraft proximity index (risk measurement)
Ac1 – ACID, position and sector of the first aircraft (paired alphabetically)
Ac2 – ACID, position and sector of the second aircraft

DR&A Count* – A data object constructed by the DraCounter containing totals and interval counts of data objects received. Contains the interval of time the objects were counted for, the total counted to this point, the total for the current interval, and the interval number.

Duration Second* – A data object constructed by the Duration Factory containing duration information on a sequence of one type of data object. Contains the start time of the consecutive states, the end time, the first event of the sequence, and the last event of the sequence.

End of Epoch – Records an update of the simulation time (adds one second).

Fix – (includes Waypoint and VORTAC). Defines an object containing fix information.

Flight – Contains initial information on a flight of one or more aircraft following a single flight plan that has been added to the simulation. Contains the aircraft ID, the start time, the starting frequency, and the filed flight plan.

Flight Activated – Defines an object containing information about a flight going from a pending state to an active state. This contains the flight initialization data sent to a SimPilot Workstation (SPW) when the flight was assigned to an operator.

Flight Terminated - Defines an object containing information about a flight that goes from an active state to a terminated state.

Flying Status Change - Records the change of a flight's status or phase of flight.

Frequency Change - Records the change of the frequency used by a flight. Contains the aircraft ID, the simulation time, the aircraft type, the new frequency, the old frequency, and the location of the change.

Gate Hold - Records the application of a gate hold to a flight. Contains the aircraft ID, the simulation time, the SimPilot ID, the frequency, the filed start time, and the runway.

Gate Hold Release - Records the release of a gate hold on a flight. Contains the aircraft ID, the simulation time, the SimPilot ID, the frequency, the start time, the filed start time, and the runway.

HFL Enroute Summary* - Defines an object containing summary statistics of measures involving the simulation complexity for a sector over intervals of time. The data contained includes several types of violations: standard separation violation (report abbreviation: secnf), a user defined separation violation (ecnf), between sector standard violations (bscnf), and NTZ area boundary violations (ascnf); number (N) and duration (D) of these outputs are provided, along with hold delays (htdly), takeoff delays (stdly), along with aircraft handled (hand), aircraft completed (comp), aircraft handed off (hoff), and other information. An example of the HFL Enroute Summary text output produced by Text Writer is:

```
HFL ENROUTE. Date: 2003-06-03  Condition:   Subj#: s00  Sector: NORTH_DEP
  Interval: 600-1199  Nsecnf: 4  Dsecnf: 274  Necnf: 3  Decnf: 167
  Nbscnf: 36  Dbscnf: 1188  CPA: 6729 ft  Horiz CPA: 6728 ft  Vert CPA: 107 ft
  API: 31.7  Nascnf: 0  Dascnf: 0  CMAV: 9.08  Alt cmds: 34  Hdg cmds: 0
  Spd cmds: 0  Nhtdly: 0  Dhtdly: 0  Nstdly: 0  Dstdly: 0  Nptt: NA
  Dptt: NA  Nhand: 13  Dhand: 6169  Dist flown: 476.9 nm  Ncomp: 0  Nhoff: 0
```

Message – A scenario status message or alert. The types of message are:
Info Message – status message on the state of the scenario.
Warning Message – alert of an unexpected occurrence in the simulation, which may or may not indicate a problem.
Error Message – report of a problem in the simulation, which may affect the validity of the simulation.

Route – A data object that defines a Jet route, a SID route or a Victor route.

Route Captured – A data object marking an aircraft's transition to following a route.

Runway – Defines a data object containing information about a runway.

Scenario Start State – Contains information about the setup and environment of the simulation scenario.

Sector – Contains information about a NAS sector of the simulation. Unless geographic sector boundaries were specifically provided to the TGF simulator for a recording, the sector's physical location is not known, and sector fields in other data objects will correspond to the aircraft's frequency.

Separation Detail* – A data object constructed by the Separation Violation Factory containing details about a separation violation. Fields of the separation violation object include: its duration, start time, end time, and details about the first second, the last second, and the closest point of approach of the violation.

```
SEPARATION VIOLATION. DURATION: 14  Start time: 00:22:19  End time: 00:22:32  Name: AWE179_N885Q
 1ST Time: 00:22:19  Distance: 2.79006 nm  Horizontal dist: 2.7693 nm  Risk API: 0.0%
  Ac1: AWE179  Lat: 39-58-26.368N  Long: 084-48-30.606W  Alt: 30980.2 ft  Sector: 98 128.775
  Ac2: N885Q  Lat: 39-57-35.232N  Long: 084-45-05.074W  Alt: 29035.9 ft  Sector: 88 120.575
 LAST Time: 00:22:32  Distance: 4.94718 nm  Horizontal dist: 4.93393 nm  Risk API: 0.0%
  Ac1: AWE179  Lat: 39-58-17.104N  Long: 084-50-39.553W  Alt: 31144.1 ft  Sector: 98 128.775
  Ac2: N885Q  Lat: 39-58-51.386N  Long: 084-44-17.114W  Alt: 29572.7 ft  Sector: 88 120.575
 CPA Time: 00:22:19  Distance: 2.79006 nm  Horizontal dist: 2.7693 nm  Risk API: 0.0%
  Ac1: AWE179  Lat: 39-58-26.368N  Long: 084-48-30.606W  Alt: 30980.2 ft  Sector: 98 128.775
  Ac2: N885Q  Lat: 39-57-35.232N  Long: 084-45-05.074W  Alt: 29035.9 ft  Sector: 88 120.575
```

Sim Terminated – A data object marking the end of a simulation.

Sp Command Result – A data object containing information about a command entered by a SimPilot (pseudo-pilot) and the result of the command.

Star Route - Defines an object containing Standard Terminal Arrival (STAR) route information.

Touchdown – A data object marking the time an aircraft touched down on the runway.

Terminal Airport Summary* - Defines an object containing summary statistics of measures involving the simulation complexity for an airport over intervals of time. The data contained includes: the airport ID, the time interval in seconds, the number of departures, the number of delayed departures, the cumulative delay of departures, the number of gate holds and releases, the cumulative duration of the gate holds, the average time between departures, and the average time between landings. An example of the Terminal Airport summary is:

```
TERM AIRPORT: PAR  Interval: 600 - 1199  NDept: 12  NDptDly: 1  DDptDly: 50
  NGateHolds: 1  NGateReleas: 1  DGateHolds: 30  AvDeptTime: 180  AvLandTime: 0
```

Terminal Summary* - Defines an object containing summary statistics of measures involving the simulation complexity for a sector over intervals of time. The data contained includes several types of violations: standard separation violation (report abbreviation: stcnf), a user defined separation violation (tcnf), between sector standard violations (bscnf), NTZ area boundary violations (ascnf), longitudinal conflicts (lcnf), and parallel conflicts (pcnf); number (N) and duration (D) of these outputs are provided, along with aircraft handled (hand), aircraft completed (comp), aircraft handed off (hoff), and counts of pilot commands.
A sample of the Terminal Summary text output produced by Text Writer consists of:

```
TERM SIM. Date: 2003-06-03  Condition:   Subject #: s00  Sector: 78
  Interval: 600-1199  Nstcnf: 3  Dstcnf: 141  Ntcnf: 0  Dtcnf: 0
  Nbscnf: 7  Dbscnf:  301  CPA:   Horiz CPA:   Vert CPA:
  API: 0  Nascnf: 1  Dascnf: 21  CMAV: 4.63  Alt cmds: 13  Hdg cmds: 1
  Spd cmds: 1  Nlcnf: 0  Dlcnf: 0  Npcnf: 0  Dpcnf: 0
  Nhand: 70  Dhand: 39056  Dist flown: 3637.4 nm  Ncomp: 41  Nhoff: 8
```

6 DRAT Report Design Descriptions

These report design descriptions are provided to explain how certain frequently requested reports are generated using the DRAT tools.

The variables in the reports that follow will be described in as much detail as necessary or additional documents will be cited as references. Variable names are arbitrary and may or may not have been used in previous research efforts. Variable concepts, however, have for the most part been employed in earlier work. Once a concept is explained, such as the principle of accumulating time duration of conflicts, it may or may not be repeated in similar variable descriptions.

6.1 CONFLICT REPORTS

Conflict reports are reports of separation violation between pairs of aircraft. "Conflicts" are not the same as the conflict alert warnings produced by NAS for controller assistance. Conflict reports include an Aircraft Proximity Index (API) calculation. The API is a measure of conflict severity developed by Mr. Lee Paul of the FAA Technical Center. Conflict report output also states the horizontal and vertical separations between the aircraft. All conflict variables assume a technical violation of minimum separation between pairs of aircraft flying in controlled airspace.

6.1.1 STANDARD CONFLICT (SCNF)

For safety reasons, aircraft should maintain a horizontal distance of at least 5 nautical miles (nm) from each other. The vertical safe distance depends on the altitude of the aircraft. For an altitude of less than 29,000 feet, the vertical separation minimum is 1,000 feet. For altitudes greater than 29,000 feet, the vertical minima increases to 2,000 feet. If two aircraft come within the horizontal and the vertical restriction of each other, they are in separation violation.

The best DRAT tool sequence to produce this report is: Recordable Reader, Separation Violation Factory, and either Text Writer or Delimited Writer. Data objects are imported from the TGF recording file by Recordable Reader, which sends them to the Separation Violation Factory. The Separation Violation Factory should be set to VIOLATE_SEP,

have Pass Through turned off, have the minimum distance setting of 5 nm and have the minimum altitude setting of -1 feet. The altitude setting of -1 feet indicates a standard conflict, causing the filter to use the two altitudes of 1,000 feet below 29,000 feet and 2,000 feet above 29,000 feet. The type of writer determines the type of output, and the file name specified is the output file. One data object per separation violation will result. Another possible DRAT tool sequence to produce this report is: Recordable Reader, Distance Factory, and either Text Writer or Delimited Writer. The Distance Factory would have the same settings as the Separation Violation Factory of the previous sequence. This configuration would generate separation violation distances for every second of the violation.

6.1.2 STANDARD CONFLICT DURATION (SCNFD)

The duration of the standard conflicts as reported by the SCNF process in 5.1.1, over intervals of the simulation.

The DRAT tool sequence for this report is: Recordable Reader, Distance Factory, Data Object Count Factory, and either Text Writer or Delimited Writer. The parameters for the Distance Factory should be set to VIOLATE_SEP, have Pass Through turned off, have the minimum distance setting of 5 nm and have the minimum altitude setting of -1 feet to indicate a standard conflict (see 5.1.1). The Data Object Count Factory should specify the interval desired by the user (or a very high number so one interval encompasses the entire length of the simulation), with Count Name Once turned on so that violations spanning more than one interval are not counted more than once, and no value for Classname and Name.

If number and duration of conflicts per interval per sector is desired, this DRAT tool sequence can be used: Recordable Reader, HFL Enroute Factory (or Terminal Simulation Factory, if for terminal airspace), and either Text Writer or Delimited Writer.

6.1.3 X-VALUE CONFLICT (XCNF)

This measure allows a user specified input of data instead of the standard separation values.

The DRAT tool sequence for this report would be the same sequence used for the SCNF process in 5.1.1; Recordable Reader, Separation Violation Factory (or Distance Factory), and either Text Writer or Delimited Writer. The only panel parameters that would differ are the Separation Violation Factory (or Distance Factory) Minimum Distance and Minimum Altitude values, which would instead be set to the values desired by the user.

6.1.4 X-VALUE CONFLICT DURATION (XCNFD)

This is the cumulative duration for XNCF. The cumulative duration is then recorded in time blocs for examination after the simulation has concluded.

The DRAT tool sequence for this report would be either one of the tool sequences that were given for the SCNFD process in 5.1.2; with the parameters only changed in that the minimum distance and altitude would be values selected by the user.

6.1.5 WAKE VORTEX (LONGITUDINAL) CONFLICT (LCNF)

When aircraft enter the designated region known as the terminal area, they must observe a change in the separation minima. The horizontal separation minimum decreases to 3 nm, while the vertical minimum remains at 1,000 feet. The significant difference is the addition of wake vortex separation restrictions when an aircraft is on a final approach sequence. Wake vortexes are produced by aircraft wings disrupting the airflow behind the aircraft; details are defined in 7110.65L (see Appendix 2). Standard separation is 3 nm, unless the wake vortex criteria apply. The criteria of the wake vortex takes into account the type of aircraft, size, and overall weight.

The DRAT tool sequence for this report is: Recordable Reader, Separation Violation Factory (or Distance Factory), and either Text Writer or Delimited Writer. Data objects are imported from the TGF recording file by Recordable Reader, which sends them to the Distance Factory. The Separation Violation Factory (or Distance Factory) should be set to VORTEX_SEP with Pass Through turned off. The type of writer determines the type of output, and the file name specified is the output file. If Separation Violation Factory is used, one data object per separation violation will result; if Distance Factory is used, one separation violation distance for every second of every violation will result.

6.1.6 WAKE VORTEX CONFLICT DURATION (LCNFD)

The duration of the wake vortex (longitudinal) conflicts as reported by the LCNF process in 5.1.5, over intervals of the simulation.

The DRAT tool sequence for this report is: Recordable Reader, Distance Factory, Data Object Count Factory, and either Text Writer or Delimited Writer. The parameters for the Distance Factory should be set to VORTEX_SEP and have Pass Through turned off. The Data Object Count Factory should specify the interval desired by the user (or a very high number so one interval encompasses the entire length of the simulation), with Count Name Once turned on so that violations spanning more than one interval are not counted more than once, and no value for Classname and Name.

If number and duration of conflicts per interval per sector is desired, this DRAT tool sequence can be used: Recordable Reader, Terminal Simulation Factory, and either Text Writer or Delimited Writer.

6.1.7 PARALLEL CONFLICT (PCNF)

This measure is implemented in order to evaluate conflicts that result when aircraft approaching the airport are on a simultaneous parallel approach vector. A simultaneous approach occurs when two aircraft are side-by-side on final approach to parallel runways. The data must be user-specified, since it is only used to examine the possibility of an accident.

The DRAT tool sequence to produce this report is: Recordable Reader, Altitude Filter, Separation Violation Factory (or Distance Factory), and either Text Writer or Delimited Writer. Data objects are imported from the TGF recording file by Recordable Reader, which sends them to the Altitude Filter. The Altitude Filter's minimum altitude is set to 0 feet and the maximum altitude is set to the maximum altitude to track the aircraft on final approach at. The Separation Violation Factory (or Distance Factory) should be set to VIOLATE_SEP, have Pass Through turned off, have a minimum distance setting slightly greater than the distance of the parallel runways, and have a minimum altitude setting of 500 feet. The type of writer determines the type of output, and the file name specified is the output file. If Separation Violation Factory is used, one data object per

separation violation will result; if Distance Factory is used, one separation violation distance for every second of every violation will result.

6.1.8 PARALLEL CONFLICT DURATION (PNCFD)

The duration of the standard conflicts as reported by the PCNF process in 5.1.7, over intervals of the simulation.

The DRAT tool sequence for this report is: Recordable Reader, Distance Factory, Data Object Count Factory, and either Text Writer or Delimited Writer. The parameters for the panels are the same as in the above PCNF process in 5.1.7, with the addition of the Data Object Count Factory with the interval desired by the user (or a very high number so one interval encompasses the entire length of the simulation), with Count Name Once turned on so that violations spanning more than one interval are not counted more than once, and no value for Classname and Name.

If number and duration of conflicts per interval per sector is desired, this DRAT tool sequence can be used: Recordable Reader, Terminal Simulation Factory, and either Text Writer or Delimited Writer.

6.1.9 RESTRICTED AIRSPACE CONFLICT (ASCNF)

Restricted airspace is a defined area in which the flight of aircraft is restricted in accordance with special conditions. This measure collects the frequency of aircraft deviations into the restricted airspace. To allow flexibility, the user can specify the boundary and enter it into the software.

The DRAT tool sequence for this report is: Recordable Reader, Geographic Area Filter, Data Object Count Factory, and either Text Writer or Delimited Writer. A Geographic Area Filter is used to determine all the instants at which an aircraft is within the boundaries of the given restricted zone. The Data Object Count Factory is set to count names once, so every instant of airspace violation is not counted separately, to determine the frequency.

6.1.10 RESTRICTED AIRSPACE CONFLICT DURATION (ASCNFD)

The cumulative durations of the conflicts reported by the ASCNF process in 5.1.9 in subtotaled time blocks.

The DRAT tool sequence for this report is: Recordable Reader, Geographic Area Filter, Duration Factory, and either Text Writer or Delimited Writer. The parameters for the panels are the same as in the above ASCNF process in 5.1.9, with the addition of the Duration Factory with minimum duration of zero and maximum duration a high number.

If number and duration of conflicts per interval per sector is desired, this DRAT tool sequence can be used: Recordable Reader, HFL Enroute Factory (or Terminal Simulation Factory, if for terminal airspace), and either Text Writer or Delimited Writer.

6.2 COMPLEXITY MEASUREMENT REPORTS

All the following complexity measurement reports are available in counts per sector, per interval using the following configuration: Recordable Reader, HFL Enroute Factory (or Terminal Simulation Factory, if for terminal airspace), and either Text Writer or Delimited Writer. The intervals for the factory will need to be set.

6.2.1 SYSTEM ACTIVITY (CMAV)

This is a measure of the average number of aircraft within a certain distance of each other. The software allows manual input of the distance between the aircraft. The typical test number is 10 nm. The sampling rate of data is taken once every 10 seconds.

6.2.2 ALTITUDE CHANGE COMMAND (ALT)

These reports include all messages sent from the controller to the aircraft advising the aircraft on altitude changes. The messages are counted over the simulation or for a specified time block.

6.2.3 HEADING CHANGE COMMAND REPORT (HDG)

These reports include all messages sent from the controller to the aircraft involving heading instructions. They are counted over the entire run, or for a pre-specified period of time.

6.2.4 SPEED CHANGE COMMAND REPORT (SPEED)

These reports include all messages sent from the controller to the aircraft involving speed instructions. They are counted over the entire run, or for a pre-specified period of time.

6.3 NON-CONFLICT ERROR REPORTS

6.3.1 MISSED APPROACH REPORT (MISSAPP)

When an aircraft cannot complete an approach due to some event, it is called a 'missed approach'. In the simulation, the frequency of missed approaches is generated within the terminal control area. This area includes the primary airport and any satellite airport to which approaches are being controlled.

The DRAT tool sequence for this report is: Recordable Reader, Flying Status Filter, Data Object Count Factory, and either Text Writer or Delimited Writer. The flying status selected by the Flying Status Filter will be “MISSED_APPROACH” with the “Last instance of status” unchecked. The Data Object Count Factory will be set to the interval desired (or a very high number so one interval encompasses the entire length of the simulation), with Count Name Once turned on so that missed approaches spanning more than one interval are not counted more than once, and no value for Classname and Name.

6.3.2 HOLD REPORT (NDLY)

This report measures the frequency and duration of hold messages that are sent to different aircraft. This value can be an indication of the complexity of a simulation or of the existence of other problems.

The DRAT tool sequence for this report is: Recordable Reader, Flying Status Filter, Data Object Count Factory, and either Text Writer or Delimited Writer. The flying status selected by the Flying Status Filter will be “HOLD” with the “Last instance of status” unchecked. The Data Object Count Factory will be set to the interval desired (or a very high number so one interval encompasses the entire length of the simulation), with Count Name Once turned on so that missed approaches spanning more than one interval are not counted more than once, and no value for Classname and Name.

If number and duration of conflicts per interval per sector is desired, this DRAT tool sequence can be used: Recordable Reader, HFL Enroute Factory (or Terminal Simulation Factory, if for terminal airspace), and either Text Writer or Delimited Writer.

6.4 Activity / Task Load Reports

All the following complexity measurement reports are available in counts per sector, per interval using the following configuration: Recordable Reader, Terminal Simulation Factory, and either Text Writer or Delimited Writer. (All but the number of departures is also available using HFL Enroute Factory instead of Terminal Simulation Factory). The intervals for the factory will need to be set.

6.4.1 NUMBER OF FLIGHTS HANDLED (NHAND)

This is the total number of flights that are handled by the controller for a given period of time. The report can be based on the entire simulation or on specified time blocks.

6.4.2 NUMBER OF COMPLETED LANDINGS (NCOMP)

This is the number of landings completed during final approach in a terminal environment. The report can be based on the entire simulation or on specified time blocks. .

6.4.3 NUMBER OF DEPARTURES (NDEPT)

This is the number of departures completed by a controller in a terminal environment. The report is based on specified time blocks or the entire run of the simulation.

6.4.4 NUMBER OF HANDOFFS (NHOFF)

This is the number of successfully completed handoffs by the controller to adjacent sectors or facilities. It applies to both en route and terminal environments.

Appendix A: Glossary

ALT - HFL designation for a report on the frequency of altitude change messages sent from controller to aircraft.
API - Aircraft Proximity Index.
ATC - Air Traffic Control.
ATWIT - Air Traffic Workload Input Technique.

CMAV - HFL designation for a report on the average number of aircraft within X miles of one another.
Configuration - a sequence of DRAT tools that operates on TGF simulator data to generate (at least) one set of output. (Some types of configurations can produce multiple output files containing different sets of output.) Each DRAT tool in the sequence operates on the simulator data resulting from the previous tool in the sequence, with a minimum of two tools needed to produce output (a reader and a writer).
CPA - the closest point of approach between two aircraft in separation violation.

Data Object - is a set of related information such as aircraft information, fix information, or pilot (pseudo-pilot) command information. A data object can be thought of as a record with multiple fields.
DASCNF - HFL designation for a report on the cumulative durations of "airspace conflicts", the frequency of aircraft entering restricted airspace.
DBSCNF - HFL designation for a report of the cumulative durations of between sector conflicts (separation violations).
DECNF - HFL designation for a report of the cumulative duration of enroute sector conflicts (separation violations) for separation distances that are user-specified.
DEPART - HFL designation for a report on the duration of departures in a terminal environment.
DHAND - HFL designation for a report on the duration of flights handled by the controller over a given period of time.
DHTDLY - HFL designation for a report on the duration of aircraft put in a holding pattern (to delay traffic) over a given period of time.
DLCNF - HFL designation for a report on the cumulative durations of longitudinal conflicts (separation violations of pairs of aircraft on final approach that are in-trail of one another).
DPCNF - HFL designation for a report on the cumulative durations of parallel conflicts (separation violations of pairs of aircraft in terminal airspace).
DPTT - HFL designation for a report on the duration of push-to-talks keyed by a controller over a given period of time.
DR&A - Data Reduction and Analysis.
DSECNF - HFL designation for a report of the cumulative durations of standard enroute sector conflicts (separation violations).
DSTCNF - HFL designation for a report of the cumulative durations of standard terminal airspace sector conflicts (separation violations).

DSTDLY - HFL designation for a report on the duration of gate hold delays between the scheduled and actual takeoff times over a given period of time.
DTCNF - HFL designation for a report of the cumulative duration of terminal airspace sector conflicts (separation violations) for separation distances that are user-specified.

EN - Designates en route airspace.

Filter - DRAT tool that allows the selection of a subset of "data objects", by removing objects not containing a specified characteristic that the filter was designed to select for.
Factory - DRAT tool that combines information from existing "data objects" to create new sets of information or new data objects.

GUI - Graphical User Interface.

HDG - HFL designation for a report on the frequency of heading instructions to aircraft.
HFL - Human Factors Laboratory.

Interval - A period of time measurement; often used to specify the length of time for each subtotal in an aggregate measurement.

MISSAPP - HFL designation for a report on the frequency of missed approaches in the terminal control area.

NASCNF - HFL designation for a report on "airspace conflicts", the frequency of aircraft entering restricted airspace.
NBSCNF - HFL designation for a report on the number of between sector conflicts (separation violations).
NCOMP - HFL designation for a report on the number of flights completed (landed) by the controller over a given period of time.
NECNF - HFL designation for a report on the number of enroute sector conflicts (separation violations) for separation distances that are user-specified.
NHAND - HFL designation for a report on the number of flights handled by the controller over a given period of time.
NHOFF - HFL designation for a report on the number of handoffs of aircraft from one sector to another over a given period of time.
NHTDLY - HFL designation for a report on the number of aircraft put in a holding pattern (to delay traffic) over a given period of time.
NLCNF - HFL designation for a report on the number of longitudinal conflicts (separation violations of pairs of aircraft on final approach that are in-trail of one another).
NPCNF - HFL designation for a report on the number of parallel conflicts (separation violations of pairs of aircraft in terminal airspace).
Nm - Nautical mile = 6080 ft or 1.85 kilometers.
NPTT - HFL designation for a report on the number of push-to-talks keyed by a controller over a given period of time.

NSECNF - HFL designation for a report on the number of standard enroute sector conflicts (separation violations).
NSTCNF - HFL designation for a report on the number of standard terminal airspace sector conflicts (separation violations).
NSTDLY - HFL designation for a report on the number of gate hold delays between the scheduled and actual takeoff times over a given period of time.
NTCNF - HFL designation for a report on the number of terminal airspace sector conflicts (separation violations) for separation distances that are user-specified.

Pass Through – An option in many of the DRAT tools that determines whether the next tool received data objects that are not specifically sent or eliminated. For example, an Aircraft ID Filter will receive three categories of data objects:

1) Data objects that are specified by the tool's Aircraft ID list,
2) Data objects that are not included in the tool's Aircraft ID list, and
3) Data objects that do not have an associated aircraft ID.

Data objects in category 3) are sent if Pass Through is enabled (checked), and are not sent if Pass Through is disabled (not checked). In contrast, data objects in category 1) are always sent and data objects in category 2 are never sent.

Reader - DRAT tool that allows the selection of an input file (generally encoded in TGF simulator recording format) to translate data into "data objects" that the other DRAT tools can operate on.
Recording File - is a file containing second-by-second information on the condition of a TGF simulation.

SPD - HFL designation for a report on the frequency of speed instructions to the aircraft.

TCA - Terminal Control Area.
TERM - Designates terminal airspace.
TGF - Target Generator Facility.

VOIDUR - HFL designation for a report containing the cumulative time, in seconds, that the controller in transmitting to the aircraft under his/her control.
VOIFREQ - HFL designation for a report on the frequency of voice communications between controllers and the aircraft.

Wake Vortex - The unstable pocket of air that is created behind an aircraft in flight.
Writer - DRAT tool that allows the selection of an output file in a specific format. Each writer generates a report to an output file, which can be read by an editor or sent to a writer.

Appendix B: Wake Vortex Turbulence Separation

7110.65L Section 5. RADAR Separation (2/26/98)

5.5.3 Minima

Wake Turbulence Application – paragraph d.

Separate aircraft operating directly behind, or directly behind and less that 1,000 feet below, or following an aircraft conducting an instrument approach by:
NOTE-Consider parallel runways less that 2,500 feet apart as a single runway because of the possible effects of wake turbulence.
Heavy behind heavy - *4 miles*.
Large/heavy behind B757 - *4 miles*.
Small behind B757 - *5 miles*.
Small/large behind heavy - *5 miles*.

Wake Turbulence Application – paragraph e. Terminal:

In addition to subpara d., separate an aircraft landing behind another aircraft on the same runway, or one making a touch-and-go, stop-and-go, or low approach by ensuring the following minima will exist at the time the preceding aircraft is over the landing threshold:
NOTE-*Consider parallel runways less than 2,500 feet apart as a single runway because of the possible effects of wake turbulence.*

1. Small behind large - *4 miles*.
2. Small behind B757 - *5 miles*.
3. Small behind heavy - *6 miles*.